TUBE-WAVE SUPPRESSION FOR SINGLE-WELL IMAGING

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RESEARCH OBJECTIVES

The objective of this project is to conduct field tests of a borehole tube-wave suppressor (TWS) in conjunction with single-well seismic imaging (SWSI). We can quantify the effects of a new TWS, developed at Idaho National Engineering and Environmental Laboratory (INEEL) by using Berkeley Lab's single-well equipment.

APPROACH

We conducted two field-scale tests. The first was in shallow wells at the University of California's Richmond Field Station (RFS). The RFS has four boreholes of 100 m depth and 6 in. diameter. These wells are deep enough to deploy the SWSI system and TWS.

A follow-up test at an oil-field site was then scheduled to test the equipment in a deep well situation. We conducted this test with Berkeley Lab's SWSI field system at Chevron's Lost Hills oil field. Chevron's CO_2 flood pilot site was extensively used. This site has permanently emplaced observation wells that are available for studies without taking production wells off-line. Berkeley Lab has previously acquired crosswell and single-well surveys at this site, which has recently undergone hydrofracturing and CO_2 injection.

ACCOMPLISHMENTS

For the first test, we recorded data with hydrophones and wall-locking geophones, both with and without the TWS. These tests allow quantification of tube-wave attenuation as well as field testing of the hardware and mechanical/electrical interface. Data were recorded by Berkeley Lab using a fiber-optic borehole digitizer. The successful completion of these tests indicated a reduction of tube waves of about 10dB, relative to the compressional P-wave.

In the follow-up test, the presumed vertical fracture zone is a particularly attractive imaging target for the single-well acquisition geometry. While useful data was acquired in the initial surveys (demonstrating the baseline properties of the site), tube waves were a major problem. We expect the seismic data to be greatly enhanced by TWS. The comparison of data collected with and without the TWS is shown in Figure 1. We see a dramatic reduction of tube-wave energy.

SIGNIFICANCE OF FINDINGS

We have shown that the INEEL TWS can dramatically reduce the tube-wave energy in a single-well seismic survey. This result is very important for the future of single-well surveys as well as other borehole seismic surveys.

RELATED PUBLICATIONS

Daley, T.M., E.L. Majer, and R. Gritto, Single-well seismic imaging—Status report, Berkeley Lab Report LBNL-45342, 2000.

Daley, T.M., Single-well seismic-imaging tests: November 1997 at Bayou Choctaw Site, Berkeley Lab Report LBNL-42672, 1998.

Daley, T.M., Single-well seismic imaging in a deep borehole using a piezoelectric orbital vibrator, Berkeley Lab Report LBNL-42673, 1997.

ACKNOWLEDGMENTS

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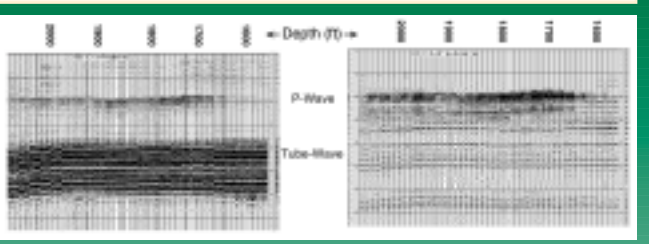

Figure 1. Single-well seismic-receiver gather from Lost Hills well OB-C1. The data were recorded using Berkeley Lab's high-frequency piezoelectric source and hydrophone sensors. A dramatic reduction in tube energy is seen when the tube-wave suppressor is used in the postinjection survey.